Section V. Non-price issues

Environmental externalities, congestion and quality under regulation

Peter Forsyth, Monash University, Melbourne, Australia.

Introduction

In is becoming increasingly recognised that problems of quality degradation, congestion and environmental externalities can be present, and often exacerbated, when industries are subjected to price regulation. A price regulated firm has an incentive to downgrade quality of its output, since it can save on costs, but need not lose much revenue, if it lowers quality For example, service quality has become an issue with privatised, regulated, electricity distributors. Congestion is an aspect of quality, and regulated firms often operate congestible facilities. This is an issue for busy airports which are subject to price regulation. Congestion also involves an element of externality, since one user imposes costs on others through lowering the quality of service they receive. As with other industries, regulated industries can generate negative environmental externalities. This could pose difficulties for regulating electricity industries if greenhouse gas emission limits are imposed.

It is convenient to begin with the problem of quality reduction under regulation; how this comes about is discussed, and options for addressing it are examined. Congestion is best treated as an aspect of quality. Finally, the control of externalities in the context of the regulated firm are discussed.

Quality under regulation

Imposing price controls, of the price-cap form, on a firm will give it an incentive to undersupply quality (Rovizzi and Thompson, 1992, Armstrong, Cowan and Vickers, 1994, pp 173–74). The mechanism is quite straightforward. The firm can gain additional revenue by adding to quality;it will also face additional costs. The profit maximising firm will equate the additional revenue from additional quality to the additional cost. However, the additional social benefits from additional quality will include the addition to consumer's surplus, and will exceed the addition to revenue. Hence the firm subject to a price control will undersupply quality.

An unconstrained monopoly would not face the same incentives. If it increased quality, it would face an upward shift in its demand curve, and it would be able to increase its price, with a consequent impact on profits. It depends on the circumstances whether a monopoly will choose the optimal level of quality (Spence, 1975); it could choose a higher or lower level, though its choice will be around the optimal level. Price control limits the ability of the firm to gain full advantage from its quality choices by stopping it from charging more when it delivers higher quality.

This situation can be compared to that of a rate of return regulated firm. This firm can pass on the costs of higher quality, and thus does not have an incentive to skimp on quality. It too does not have an incentive to choose the level of quality that consumers are willing to pay for, and depending on the nature of the regulation, it may have an incentive to oversupply quality, especially if the allowable rate of return exceeds the firm's cost of capital. Higher quality may necessitate a larger capital base, and thus higher absolute level of profit. Rate of return regulated firms are often accused of 'gold plating', and supplying a higher level of quality than the consumers require. The publicly owned firm has ambiguous incentives towards quality. It may wish to maximise size of operations, and this might be achieved by supplying too high a level of quality. It might be under pressure from its owners to minimise (politically inconvenient) risks, and may play safe by providing too high a quality. On the other hand, public firms may not be responsive to consumers, and may take an easy way out by supplying too low a level of quality. While public firms face some pressure to take quality and its costs into account, and many strive to provide the quality which consumers want, there is no reliable mechanism to ensure that owners and managers seek the ideal quality/cost solution.

Congestion

Congestion can be regarded as an aspect of quality which depends on the relationship of demand to capacity. As demand grows relative to capacity, the quality of the service received by the users declines; they may face delays in obtaining service, the service may become less predictable, or facilities may be overcrowded. The costs of congestion are borne by the users, and the users are in the hands of the facility provider to supply sufficient capacity to enable an efficient level of quality. When congestion mounts, it can be lessened by pricing to reduce usage, by non-price rationing (e.g. slot controls at airports), or investment to increase the capacity of the facility. In a situation of growth of demand, there will come a point where the last option, which is the most expensive, will be warranted.

A price regulated utility cannot use price to lessen congestion. It could implement non-price methods of rationing demand, but it does not have an incentive to do this; it will gain additional revenue and profit if it increases throughput, and it will have an incentive to allow extra demand even though users face a high cost in terms of congestion. It will not have an incentive to invest to lessen congestion, since it will have to pay for the investment, but its customers will enjoy the benefits of reduced congestion, and it will be unable to recover the costs of investment via higher prices. Thus a price regulated utility will allow congestion to be too high, and will under-invest in capacity (for an application to airports, see Forsyth, 1997). Unconstrained profit maximising firms, by contrast, will take congestion into account because they will be able to charge users more if they supply a less congested service.

Access Pricing

The possibility of quality degradation when access prices are regulated is issue which has not been much attention, though its consequences could be considerable. In Australia there has been a shift towards breaking up hitherto monolithic utilities, and making it possible for competitors to be able to use essential facilities owned by the incumbent monopolist by setting up an access regulatory regime (King and Maddock,

1996). A utility which is required to provide access to its competitors will face the same sorts of incentives, if access prices are regulated, as would a utility which is selling in the final goods and services market. It will be able to lower costs if it reduces quality, and it will be unable to profit if it increases quality since it will not be permitted to charge more. Thus it will have an incentive to supply an inefficiently low level of quality to its competitors.

However, there is a further effect which could prove even more serious in the access situation. A facility provider will not only save costs by supplying low quality services to its competitors, but it will also be able to lessen their effectiveness as competitors. At the extreme, it could supply such low quality services that its competitors were unable to compete, and its monopoly in the final goods and services market would be restored, even though it is required to provide access. By supplying low quality services, the utility either increases the costs of its competitors, or lowers the quality of the services they are unable to sell, or both; whatever happens, the utility will be able to sell its output at a higher price than if it were forced to supply its competitors with the same quality of service that it has been supplying to itself. The utility can use quality degradation as a device to partly or fully get around the access price regulation.

If the utility is not price regulated, and is allowed to negotiate with access seekers on access price, it will not have this incentive to lower quality. It will only sell to its competitors at prices which are profitable to itself. It will either not lose if competitors are selling comparable quality services, and it can gain from selling to them if they are more efficient than itself in producing the downstream service. The utility will not have an incentive to lower quality if an access price set at the Efficient Components Pricing Rule (ECPR) level, (see Baumol and Sidak, 1994, for a discussion of ECPR) since it will not lose if a competitor replaces it to some extent in the final goods and services market.

It is difficult to obtain empirical evidence on how serious a problem this is likely to be. Access seekers often complain that the standard of service they are being supplied with is lower than that supplied by the facility owner to its own divisions, and that their ability to compete is thus restricted. It has also been maintained that there are fewer disputes over quality of service in the New Zealand telecommunications industry, where access prices are set by negotiation (with some government pressure), than telecommunications industries where access prices are regulated.

Valuing quality

If the quality problems identified in the preceding sub-sections are to be addressed, the regulator needs to know the value the users put on quality. When there is no regulation, firms solve the quality choice themselves; perhaps by a method of trial and error, they find out what the market is prepared to pay for. This method is no longer available, since the nexus between prices, revenues and quality is now broken. The regulator must use other information to try to determine what quality level to impose.

Typically, there will be an attempt to identify what physical aspects of quality are important; depending on the nature of the utility, there will be a range of quality indicators which are relevant. Some of these may have been collected for some time, perhaps well before corporatisation or privatisation of the utility. However, because

quality issues become more critical under new arrangements, it is often the case that a whole new range of indicators will need to be developed. These will cover the nature of the product, such as impurities in water, delays in obtaining service, as with airport delays, delays in getting connections re-established, as in telecommunications, service reliability, as in electricity, and safety aspects. It is usually fairly easy to determine which are indicators are most appropriate for a particular utility; the main problem is that the list is likely to be a long one.

The next stage is to determine what trade-offs users are prepared to put on different aspects of quality and price. In some cases, users themselves may be poorly informed about an aspect of quality, and may not be able to choose optimally. For example, users are typically not informed about the disease risks in the water they drink; they just presume that it is safe. Where externalities may be linked to quality, for example, there may be public health aspects to water quality, users preferences will need to be supplemented with information about the costs of the externalities. For the most part, the regulator's task is to determine what trade-offs users would be prepared to make.

One option is to assume that existing levels of quality are appropriate, and try to ensure that these are maintained. This may be an inappropriate assumption where there the utility had no strong incentive to offer the optimal level of quality previously; as noted before, public or regulated firms can have incentives to supply excessive or deficient quality. Another option is to use yardsticks; to find out the quality levels comparable utilities are offering, and to use these as the standards. Regulators which are doubtful about whether existing quality levels are appropriate can undertake surveys of users, to try to determine their willingness to pay for different quality levels. Finally, there may be some synthetic means of estimating what users are prepared to pay for some aspects of quality. For example, it is possible to make estimates of the cost of delays to aircraft caused by congestion at airports using measures of the value of time of passengers and aircraft operating costs. None of these methods is perfect, but it should be borne in mind that unconstrained firms also face imperfect information on what users are prepared to pay for quality, and thus their decisions can be subject to a degree of error as well.

Regulating quality

Once the regulator has decided what values to put on different aspects of quality, there are several ways in which it might impose its preferences. A simple means is to have quality standards. Various indicators are developed, and particular standards are established. Data on performance are collected regularly, and these are compared to the standards. Simple monitoring may sometimes be sufficient to induce the utility to maintain adequate standards. Often this will be insufficient, and standards will have to be enforced. Fines might be imposed for failure to achieve standards. Conformity with standards may be made a condition for renewal of the licence to operate. An approach which is gaining in popularity is the contract with the customer, whereby the utility contracts to supply the customer with a stated standard of service, and is required to pay the customer specified amounts should it fail to meet the standards. These methods have the advantage of practicality, though they do involve the regulator in becoming much more directly involved in the operations of the utility; this is not 'light handed' regulation.

Another approach is to try to give the utility an incentive to choose the optimal level of quality by including quality directly in the price-cap. This is done by taking some indicators of quality, and by varying the allowable price according to performance in the quality indicators; a utility which increases quality will be allowed a higher price. This approach is not often followed in its pure form, though approximations to it exist. In the UK water utilities were allowed a higher price-cap in recognition of investments they would be making to improve water quality. Also in the UK, airports have been allowed higher price-caps on condition that they made investments which lessened congestion for aircraft and passengers (Forsyth, 1997).

It may well be that some forms of quality are so important that they warrant specific regulation by a body separate from the regulator. For example, airport congestion can be alleviated by restriction use of the airport at busy times, and by allocation slots for use in some manner; these slots could be given to existing users according to some rule, or they could be auctioned. Whichever approach is adopted, there will need to be some body charged with the slot management of the airport. Such a body will require skills quite separate form those of price regulating, though it will need to operate in close cooperation with the price regulator.

Externalities and regulation

The nature of the problem posed by externalities is well known. When externalities are associated with a production process, they involve either a cost or a benefit to the economy at large, but not to the producer. The producer does not take them into account when determining how much to produce, and thus either produces too much, when the externality is a cost, or too little, when the externality is a benefit. To correct the externality, it is necessary to induce the producer to alter its production, perhaps by quantitative controls or by imposing a tax or subsidy related to the externality. When the producer is subject to regulation, such as price-cap regulation, there are a number of issues which arise concerning how externalities can be controlled within this environment. These are considered in this section.

Another well known problem which is common to all externality problems concerns valuation of the externalities, or establishing what trade offs with other variables are appropriate. To reach an efficient solution, it is necessary to put a value on the externality. Since, by its very nature, the externality is not something traded in a market, there will be no established market valuation for it. A range of techniques for estimating the value of externalities have been developed; these include estimating the implicit valuation through hedonic means (e.g. measuring the cost of aircraft noise from house prices), contingent valuation methods (such as surveys of values people put on environmental features), or assessments of the cost of eliminating the externality. These will not be explored here; it suffices to note that all of the problems of establishing a value for externalities are normally present when regulated firms are the generators of externalities.

Techniques of control

There are several ways in which externalities are controlled. Three general approaches, which encompass a wide range of controls, are arbitrary standards, quantity constraints and taxes.

Arbitrary standards and prohibitions are simple, and often effective means of controlling externalities, though they are blunt in their effects, and do not usually result in an optimal level of output being achieved. Some examples of these include airport night curfews, requirements to put cables underground and bans on effluent discharges. Several of these are all-or-nothing controls, and there need be no attempt to make it possible for the firm to create the externality if it is prepared to pay for doing so. This type of control can be enforced by fines for not conforming, or by refusing licences to produce if conditions are not met.

A second type of control is the quantitative limit. A firm or industry is permitted to create externalities up to a defined limit; beyond this it is not allowed to create any more externalities. This limit may be enforced through heavy fines or licence conditions. Examples might include limits on emissions of air impurities, limits on emissions of greenhouse gases and limits on wastewater put into a river. In principle, the level of the limits would be set optimally, such that the gains to the producer from an additional unit of externality created are equal to the additional environmental costs imposed. In some cases, the limits may be determined by a jurisdiction higher than that of the regulator; for example, allowable greenhouse gas emissions may be set by international negotiation. Quantitative limits may be set directly for a specific firm, or they may be set for all producers of the external effect which is to be controlled.

Even if the level of the externality has been set optimally, there need be no certainty that the rights to create the externality will have been allocated optimally between the producers. For example, if all producers are required to cut back the externality by equal amounts or in equal proportions, this may impose significantly higher costs on some producers than others. A means to minimise the costs of meeting the constraint is to have tradeable permits to create the externality (Wills, 1997, Chapter 15). Permits to create the externality which add up in total to the allowable level of the externality are allocated, in some way, to the producers; once allocated, these can be traded amongst the producers such that those which suffer the highest costs in reducing the externality can purchase more permits, thus minimising the cost of achieving the overall target. If there is no means for minimising the costs of eternality reduction such as by tradeable permits, the imposition of quantity constraints can result in two sources of inefficiency; through the overall quantitative limit being set too high or low, and through the costs of achieving the constraint being higher than necessary.

A third method of control is to impose a tax on the production of the externality; ideally this tax would equal the marginal cost of the externality. This is the Pigovian approach, and it is often taken by economists as the preferred option. It has the advantage that it will induce the producer to choose the most efficient level of production, taking into account private and external costs. An example of this type of tax would include a noise charge for aircraft; if charges depend on the noisiness of the aircraft, the airline would take the noise generated into account as a cost of operation, and it would have an incentive to substitute quiet for noisy aircraft.

Prices versus quantities

The normal preference of economists is for price methods of intervening in markets to correct for market failures; in this case, the price method would involve setting a tax equal to the marginal cost of the externality. When certainty is present, such a tax would result in an efficient level of the externality, and minimisation of the costs of not producing it. However it need not be the case that price methods are best when uncertainty is present; even a tax set at the optimal level might perform worse than a quantitative limit (Weitzman, 1974). This presumes that there is an efficient allocation of the quantitative limits amongst producers; this may not always be the case.

The preference for price or quantitative methods of control depends on how uncertainty impacts on demand and supply, and on the shape of the relevant curves. Looked at another way, it depends on whether the marginal cost of the externality or the optimal level of the externality are better known.

A price method of control would be superior if the marginal cost of the externality is constant and known fairly accurately. In this case, uncertainty would mainly impact on demand; which could be high or low. In either case, it does not matter how high demand is, since the marginal cost of the externality depends little on the amount of the externality created. A tax set equal to the marginal cost of the externality will induce firms to make efficient production decisions, by effectively internalising the externality.

By contrast, suppose that demand is uncertain, and the marginal cost of the externality is also quite uncertain. This could be because it depends on how much of the externality is created; suppose that the marginal cost is low up to a point, but if more of the externality is created, the total and marginal cost rises very rapidly. In this situation, there is an effective natural limit to the externality that can be created. The objective of the control is to induce the producers to choose to create the efficient level of the externality. If a quantity limit is set at or about the critical level of the externality, beyond which it becomes very costly, the producers will choose to create the efficient level of the externality.

If a tax were imposed, it could well get matters badly wrong. Suppose a low tax were levied; if demand were high, there would be far too much externality created Alternatively, a high tax would excessively discourage production when demand turns out to be low. Even a tax which is optimally designed to take account of uncertainty and which maximises expected net benefits will be too high sometimes and dangerously low at other times. A quantitative limit will ensure that production is as close as practical to the optimum.

The problem with the quantitative limit is that it may not be allocated efficiently amongst producers. A limit might be of the form of an allowable total amount of pollution to be allocated amongst a number of firms. These rights to pollute will be valuable. If they are allocated on an arbitrary basis, such as pollution emissions by firms in the past, the cost of conforming to the limit will probably not be minimised. If the rights are tradeable, and an active market develops, they will be allocated so that the costs of conforming to the overall limit is minimised. For efficiency purposes, it is important that rights be traded and firms adjust to the costs of the externality; the rights

can be allocated initially using several mechanisms, with different implications for distribution. Giving the rights to producers will be in their interests, but auctions of the rights would result in the revenues going to the government.

There are likely to be real situations where the quantitative approach is preferable to the price approach. One of these would be where there is a requirement to reduce greenhouse gas emissions. Suppose that Australia commits itself to specific greenhouse gas emission targets. The electricity industry is one of the main generators of these emissions, but other sectors, such as transport contribute. Different types of electricity generators contribute to emissions differently; brown coal contributes the most per unit of electricity produced, black coal the next, gas rather less, and hydro not at all.

The response of the electricity and transport industries to a carbon tax is not known; thus it is very difficult to set a carbon tax at the level which will meet the target. If an overall limit is established and enforced, and tradeable rights to create emissions are established, the target can be met exactly. A market for the rights will develop, and the price of the rights will be established. Electricity producers, along with other creators of gas emissions, will adjust to the cost of creating emissions, and this will lead to shifts within the industry. For example, there will be a greater reliance on gas and black coal at the expense of brown coal. There will also be trading in rights between electricity and other industries. How individual firms are affected will depend on how the rights are allocated; brown coal producers may gain, even though they reduce their own output, if rights are given to existing producers rather than auctioned.

As long as an efficient market in rights comes about, a system of quantitative limits and tradeable permits to emit are likely to be the most efficient practical means of achieving gas reduction targets. Price solutions, such as carbon taxes, will not be as effective achieving the targets. Whichever approach is used, there will be issues posed for regulators.

Price regulation with externalities

The issue for the regulator is how to allow for the cost of externality controls in the price regulation framework. Externality costs will raise costs to the firm; it will have to pay externality taxes, it will have to pay for tradeable permits purchased, and it may adjust its production process to lessen externalities created, though this will be at some cost to itself (for example, a brown coal electricity generator may switch some of its production to gas, but at a cost). There is also the possibility that the regulated firm may gain from the externality controls, if it is allocated more tradeable permits than it needs for itself, and it sells them.

If the system of externality controls is in place before regulation commences, it may be straightforward to allow for. If price-caps are being used, the initial price-caps can be set at a level which allows the firm to earn a profit under current externality controls, the costs of which are known, and to which the firm has adapted. Problems emerge when externality controls are altered, or introduced for the first time. This need not pose a problem if there is rate of return regulation; the costs of the externality controls will be an allowable cost for the firm which will be permitted to pass them on to users, whatever their level is. However, price-caps are now a preferred method of regulation,

and there are difficulties in handling externality charges when these are in place. The price-cap will have to be altered; this may happen when the 'X' factor is subject to its periodic review, but if the externality charges are large and suddenly imposed, it may be necessary to have a special review.

One option is to allow full pass through of externality charges. This, however, would create very poor incentives; the firm would have no incentive to reduce its creation of externalities, since it can pass on all of the charges associated with them to users. An efficient response to the imposition of externality would normally involve the firm reducing the externality, though at the expense of some increases in cost of production, such that the total of the two is minimised.

Another option is for the regulator to make a forecast of the likely cost increase imposed on the firm created by the externality control, and to adjust the price-cap so as to enable the firm to remain profitable. This would involve the regulator in estimating the minimum cost response by the firm to the control; the maximum cost to the firm would be that if it continues the previous level of externality creation, and does not adjust. In many cases, the firm will be able to adjust, especially over the long run, and reduce the cost of meeting the externality controls. It is likely, in many cases, the regulator will not be able to make an accurate estimate of the cost increase; it will not know how the firm will adjust, and it may not know the unit cost of the externality (for example, if there are to be tradeable permits, it will not know what these will sell at). If it chooses this approach, there is the possibility that the regulator will impose a price-cap which enables the firm to make large profits or forces it into losses. There will be some opportunity for the regulator to revise its price-cap in the light of additional information; such as when trading in externality permits becomes established and prices are known, or when substitution possibilities open to firms become clearer. However, price-caps can impose considerable risks on the firm.

An alternative approach, which may impose less risk on the regulated firm, would be to allow partial pass through of the externality cost. This gives the firm some incentive to reduce costs through reducing the externalities it creates, but protects it somewhat against the risks if externality costs turn out to be very high. This would be an example of moving the regulatory system towards one of mixed or sliding scale regulation, under which allowable prices are set partially with reference to the firm's actual costs, and away from pure price-caps (see Mayer and Vickers, 1996 and Crew and Kleindorfer, 1996). This lessens the risks to the firm but also lessens its incentives to minimise costs.

In some cases, the regulator may be able to resolve the problem by shifting the externality charge on to the users, rather than the regulated firm. This would be appropriate if it is the users who are the primary creators of the externality, and not the regulated firm; if so, the users would be able to alter their behaviour to lessen the overall cost. Thus airports are associated with aircraft noise; however, the airport itself has little control over the amounts of the externality created. Noise charges can be levied directly on airlines, and if properly structured (with lower charges for quiet than noisy aircraft), they will have an incentive to minimise the overall costs by substituting quiet for noisy aircraft. This is happening at Sydney airport, where differential charges levied on airlines are giving them an incentive to lessen aircraft noise (Forsyth, 1998).

Except in cases where it is feasible to handle the problem in this way, there is no simple solution to the problem of incorporating externality controls into price-cap regulation. This is so regardless of the form of the control; whether tax, quantity limit or arbitrary restriction. The problem is not great if there is little uncertainty about the cost of the externality control and how the firm can adjust to it. The problem is also not great if the externality costs are large as a proportion of the firm's total costs. However, there can be cases where the externality controls involve large and uncertain costs; this would be so if greenhouse gas emission controls are imposed on electricity generators. It is difficult to allow for large uncertain costs within a regulatory framework which avoids imposing too much risk on the firms but also preserves their incentives to minimise costs.

Separate regulators

It is quite likely that there will be separate economic (or price) and environmental regulators. The price regulator is not likely to have expertise in environmental matters, and the environmental regulator is not likely to have expertise in economic aspects of the industry's operation. Problems can develop as a result of this separation.

One obvious source of possible difficulty lies in the two regulators having different objectives. This will translate as different weights being put on to aspects of the firm's operations, and different trade offs for objectives. At the extreme, this could lead on regulator to be encouraging what the other is attempting to discourage. Inconsistencies can develop, and these can make it difficult for the firm to meet all of its requirements simultaneously.

At a more practical level, problems can develop as a result of having separated regulation, and what is essentially a two stage regulatory process. Ideally, the regulated firm should be induced to produce and price at a level which maximises overall net benefits, balancing environmental as against other costs. However, a two stage process involves one regulator setting its conditions, and then another. The environmental regulator may not have a good idea of the costs of meeting its requirements when it is setting them, and the economic regulator may not have a good idea of the environmental consequences of its rules. Thus, even if the two regulators are agreed about objectives and trade offs, their separate actions may make it difficult to achieve an overall efficient solution; there is no body charged with overall optimisation.

As an example, consider airport noise. The airport may be subject to a price regulator and to an environmental regulator concerned about noise. The price regulator may impose rules which encourage use of the airport in the off peak; which may be a time when noise costs are high. The environmental regulator may change flight paths to lessen noise; this may reduce the capacity of the airport, and result in delays and necessitate investment, which will add to the cost base of the airport. The price regulator will need to revise its controls in the light of this. Neither regulator is attempting to determine the best solution overall; both are solving part of the problem. Good communications between the regulators will help, though neither one is able to take all aspects into account, and to implement a solution which is the best feasible overall.

Conclusions

Problems of quality choice, congestion and eternalities exist with the utility and transport industries, but these become acute when these industries are subject to regulation, especially of the price-cap form.

In the case of quality, price-caps create an incentive for the firm to supply a less than optimal level of quality. This is especially a problem when access prices are being regulated. The firm being required to provide access at a regulated price can save on costs by lowering quality, but, in addition, it can make it more difficult for its rivals to compete, by supplying a lower level of quality than it does to itself. Congestion is essentially another aspect of quality; one which depends on the relationship of demand to capacity. The firm cannot convert reductions in congestion into higher revenue because its price is capped. Thus the firm has an incentive to provide too little capacity and allow congestion to be inefficiently high.

Arguably the most difficult problem posed for regulators is that of evaluating quality, to determine the appropriate level for the firm to provide: this is difficult because regulation breaks the nexus between price and quality. Once this is done, quality can be monitored, standards enforced, and incentives for providing appropriate quality levels can be built into the price-cap. This is sometimes done in an ad hoc way, with firms being offered easier price-caps if they invest to improve quality or reduce congestion.

Externalities are present with regulated utility and transport industries, and as always, they can be difficult to evaluate. Of the available methods of control, economists normally prefer price methods, such as Pigovian externality taxes, though under uncertainty, quantity limits can be preferable. Problems are created for regulators when firms are subjected to externality charges or must purchase permits. If full pass through is permitted of the costs to the firm of the charges or permits, it will face no incentive to minimise overall costs, including externality costs. If no pass through is allowed, and there is considerable uncertainty about the costs of the externality, very large risks would be imposed on the firm. Mixed systems of regulation, which permit partial pass through of the externality charges, may strike the best balance. A further problem for regulation is the likely existence of separate price and environmental regulators. Even if these have similar objectives and trade offs, there will be a problem of how their separate decisions can be coordinated to secure the best overall result.

Bibliography

Armstrong, M., S. Cowan and J. Vickers, 1994, *Regulatory Reform: Economic Analysis and British Experience*, Cambridge Mass., MIT Press.

Baumol, W. and G. Sidak, 1994, *Toward Competition in Local Telephony*, Cambridge, Mass., MIT Press.

Crew, M. and P. Kleindorfer, 1996, 'Incentive Regulation in the United Kingdom and the United States: Some Lessons', Journal of Regulatory Economics, May, pp 211–225.

Forsyth, P., 1997, 'Price Regulation of Airports: Principles with Australian Applications', Transportation Research-E, 33:4, pp 297–309.

King, S. and R. Maddock, 1996, *Unlocking the Infrastructure*, Sydney, Allen and Unwin.

Mayer, C. and J. Vickers, 1996, 'Profit Sharing Regulation: An Economic Appraisal', Fiscal Studies, February, pp 1–18.

Rovizzi, L. and D. Thompson, 1992, 'The Regulation of Product Quality in the Public Utilities and the Citizen's Charter', Fiscal Studies, 13(3):74–95.

Spence, M., 1975, 'Monopoly, Quality and Regulation', Bell Journal of Economics, 6:417–29.

Weitzman, 1975, 'Prices vs. Quantities', Review of Economic Studies, 41:477–91.

Wills, I., 1997, *Economics and the Environment : A Signalling and Incentives Approach*, St Leonards, Allen and Unwin.